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DETERMINING MEAN PREDICTED PERFORMANCE FOR ARMY JOB FAMILIES

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13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 words)*: The present study is designed to obtain mean predicted performance (MPPs) for the 9- and 17-job families, using composites based on 7 ASVAB tests, using a triple cross-validation design permitting completely unbiased estimates of MPP. White the authors have previously computed MPPs for 9 and 17 family composites, they have not been computed for composites that have had all hierarchical effects removed by a transformation to the Army conventional standard score (ACSS) scale (with its use of equal means and equal standard deviations).

The specific research objectives are as follows:

1. To compute regression weights for the 7 ASVAB tests to form assignment composites corresponding to the two alternative second-tier structures (9 or 17 families) and to determine the classification efficiency in terms of MPP that would result from the use of all positive weights and the conversion of the composite scores into the ACSS scale. Weights are corrected first for unreliability of the criterion and, then, for restriction in range effects due to assignment from an Army input population to MOS samples. The weights are applied to test scores of independent samples to obtain back (biased) and cross (unbiased) MPPs. (continued)

15. SUBJECT TERMS

Armed Services Vocational Aptitude Battery (ASVAB); Army aptitude area composites; personnel classification

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Abstract (continued)

2. To obtain MPPs for the two sets of job families for the youth population as described in (1) above. This involves a correction due to assignment from the Army input population into Army jobs, and then a separate restriction in range correction due to selection from the youth population into the Army.
3. To compare MPPs for the two sets of job families for the Army Input/youth populations.
4. To evaluate the relative value of the two sets of job families taking into account MPPs and composite validity coefficients, used in establishing cut scores for the ACSS scale.

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Determining Mean Predicted Performance for Army Job Families

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INTRODUCTION

"Interim" Aptitude Area (AA) composites were adopted by the Army in January 2002, while research continues on the benefits and costs of moving to a proposed two-tiered classification system. The interim composites reflect a nine job family composite structure based on a 7-test ASVAB, where least squares regression is used to estimate the weights (applied to ASVAB tests to form the composites). The composites, in turn, are referred to as LSE composites.

Zeidner, Johnson, Vladimirsky and Weldon (August 2000) developed the two-tiered classification system that will be tested as part of the ongoing Enlisted Personnel Allocation System (EPAS) field evaluation test. The proposed system uses an invisible or black-box first tier in which separate assignment variables (AVs) are computed for 150 job families. The first tier AVs are to be used in assigning recruits to entry-level MOS. The second tier consists of either 9 or 17 job families to be used in recruiting, counseling and administration. These 9 or 17 aptitude area (AA) scores, each corresponding to a job family, would be recorded on the personnel records of each soldier.

The principal research finding of the proposed two-tiered system was that the unbiased overall mean predicted performance (MPP) of the 150 job family structure was .195, compared to the MPP of the then-existing unit-weighted AA operational system of .023, a gain of more than eight fold. The unbiased overall MPP for the second tier 17 job families was .145. The 17 family structure was obtained by shredding the existing AA families within the boundaries of the operational classification families to maximize the Horst index of classification efficiency. The 9-family composites were found to have an overall MPP of .123, more than five times greater than

the unit-weighted AA composites. The research utilized data obtained from the Army's Skill Qualification Test (SQT) program over the 1987 - 1989 period.

Since the publication of the Zeidner, et al. August, 2000 study, DOD decided to reduce the 9 ASVAB tests to 7 tests by removing the Numerical Operations (NO) and Clerical Speed (CS) tests from the battery. The tests were dropped from the battery in part because of the difficulty of maintaining computer-administered speeded tests and in part because of the small contribution that NO and CS made to predictive validity in the selection process.[1]

OBJECTIVES

The present study is designed to obtain MPPs for the 9- and 17-job families, using composites based on 7 ASVAB tests, using a triple cross-validation design permitting completely unbiased estimates of MPP. While we have previously computed MPPs for 9 and 17 family composites, they have not been computed for composites that have had all hierarchical effects

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[1] The authors recently conducted a comprehensive examination of validities embracing the proposed first tier (150 job families), the second tier (17 job families), and the interim LSE battery (composed of the 7-test ASVAB for 9 operational job families) – see Zeidner, Johnson, Vladimirsky, and Weldon (November 2002). Composite validities are often used as a conventional index of merit in selection programs and they are also used in the process of establishing cut scores for jobs, generally employing youth population validities. Validity coefficients, being one component of the computational process, are not as meaningful an index of merit as differential validities or, even more significantly, MPP in classification.

removed by a transformation to the Army conventional standard score (ACSS) scale (with its use of equal means and equal standard deviations).[2]

The ABC (triple cross-validation) design is used in simulation experiments, permitting completely unbiased estimates of MPP (Zeidner, Johnson, Vladimirsky & Weldon, August, 2000). The independent estimate of criterion scores is based on pure least squares estimates (LSEs) using either positive or negative weights. These weights are corrected for restriction in range to the youth population. The estimate of predicted criterion scores for computing MPPs uses weights computed in the analysis sample to obtain pure LSEs of the criterion. These weights are permitted to be either positive or negative, in contrast to the LSEs from an independent analysis sample that are used to make assignments. The assignment LSEs are constrained to be all positive.

The specific research objectives are as follows:

1. To compute regression weights for the 7 ASVAB tests to form assignment composites corresponding to the two alternative second-tier structures (9 or 17 families) and to determine the classification efficiency in terms of MPP that would result from the use of all positive weights and

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[2] An earlier study (Zeidner, Johnson, Vladimirsky, & Weldon, December 2000) was undertaken to determine the effect on classification of reducing the ASVAB from 9 to 7 tests by dropping NO and CS. It was found that the unbiased overall MPP for classification was significantly lowered by 6.2 percent in the total sample for the 150 job family and by 8.7 percent for a 66 job family structure.

the conversion of the composite scores into the ACSS scale. Weights are corrected first for unreliability of the criterion and, then, for restriction in range effects due to assignment from an Army input population to MOS samples. The weights are applied to test scores of independent samples to obtain back (biased) and cross (unbiased) MPPs.

2. To obtain MPPs for the two sets of job families for the youth population as described in (1) above. This involves a correction due to assignment from the Army input population into Army jobs, and then a separate restriction in range correction due to selection from the youth population into the Army.

3. To compare MPPs for the two sets of job families for the Army Input / Youth populations.

4. To evaluate the relative value of the two sets of job families taking into account MPPs and composite validity coefficients, used in establishing cut scores for the ACSS scale.

METHOD

The triple cross-validity design previously used in a number of ARI funded research studies on personnel classification efficiency were accomplished using 9 ASVAB tests whose validity coefficients were corrected for restriction-in-range to the Army input population (AIP). These prior studies also used regression weights that were not constrained to be positive, and usually the composites were not constrained to have equal standard deviations. These conditions contrast with the characteristics of the interim LSE composites; the latter are based on seven tests with validity coefficients corrected for restriction-in-range to the youth population (YP), and use least square weights that are constrained to be all positive. Since the estimation of the classification efficiency of composites proposed for operational use is the objective of this study, composite weights are

selected that maximize the validity coefficient obtainable from using all positive weights, even if one or more of the 7 tests cannot be utilized in a particular composite under this constraint.

This study will provide the classification efficiency of several sets of composites formed using the 7 ASVAB tests. These composites will use only positive weights, and classification efficiency will be computed in terms of mean predicted performance (MPP) after optimal assignment to job families. The standard deviations of each set of composites will be constrained to be equal within each set to correspond with the composites previously used operationally by the Army. MPP values will also be computed for the previously operational unit-weighted composites, using the 7 (retained) ASVAB tests and validity coefficients corrected to the AIP or YP.

The scores for the nine interim best weighted composites are obtained operationally by applying least square weights (u_j) to the operational test scores and adding a raw score regression constant (k). The same composite scores can be obtained by applying standard score weights (betas) to statistical standard scores based on estimates of the population means and standard deviations. The latter approach will be used in this study.

Unbiased MPP results will be obtained by using the triple cross-validation design which requires the use of three independent samples: (1) the "analysis sample" for computing the best weights for the composites used for making assignments; (2) the "evaluation" sample for computing the regression weights used in computing predicted performance scores (after optimal assignments are made); and (3) the "cross" sample which supplies the test scores to which the weights from the first two samples are applied in order to both make optimal assignments and to compute MPPs. The beta weights computed in the analysis sample will be constrained to be

positive, while the betas computed in the evaluation sample will be permitted to be either positive or negative in order to provide true least square estimates based on the 7 ASVAB tests.

Samples A and B are used as the analysis and evaluation samples and a smaller Sample C is used as the cross sample. Each MPP reported in this study will be the average of an MPP in which Sample A is the analysis sample and a corresponding MPP in which Sample B is the analysis sample. The triple cross-validation design is depicted in Figure 1.

When the regression weights are being corrected to the AIP, the test scores in Sample C are converted to statistical standard scores (SSSs), using the test means and standard deviations (SDs) computed in the analysis sample, for the application of the analysis sample weights. Similarly, the test means and standard deviations computed in the evaluation sample are used to compute SSSs against which the application of evaluation sample weights are made. This approach was also utilized in the more recent of the prior triple cross-validation studies in which MPP was computed.

When the regression weights are being corrected to the YP, the test scores in Sample C are converted to SSSs using the YP test means of 50 and SDs of 10, regardless of whether Sample A or B is used as the analysis sample.

The correction of regression weights for restriction-in-range follow the procedures described in the Appendix. MPPs for the three sets of composites will be separately computed using weights and validity coefficients corrected to the YP and the AIP.

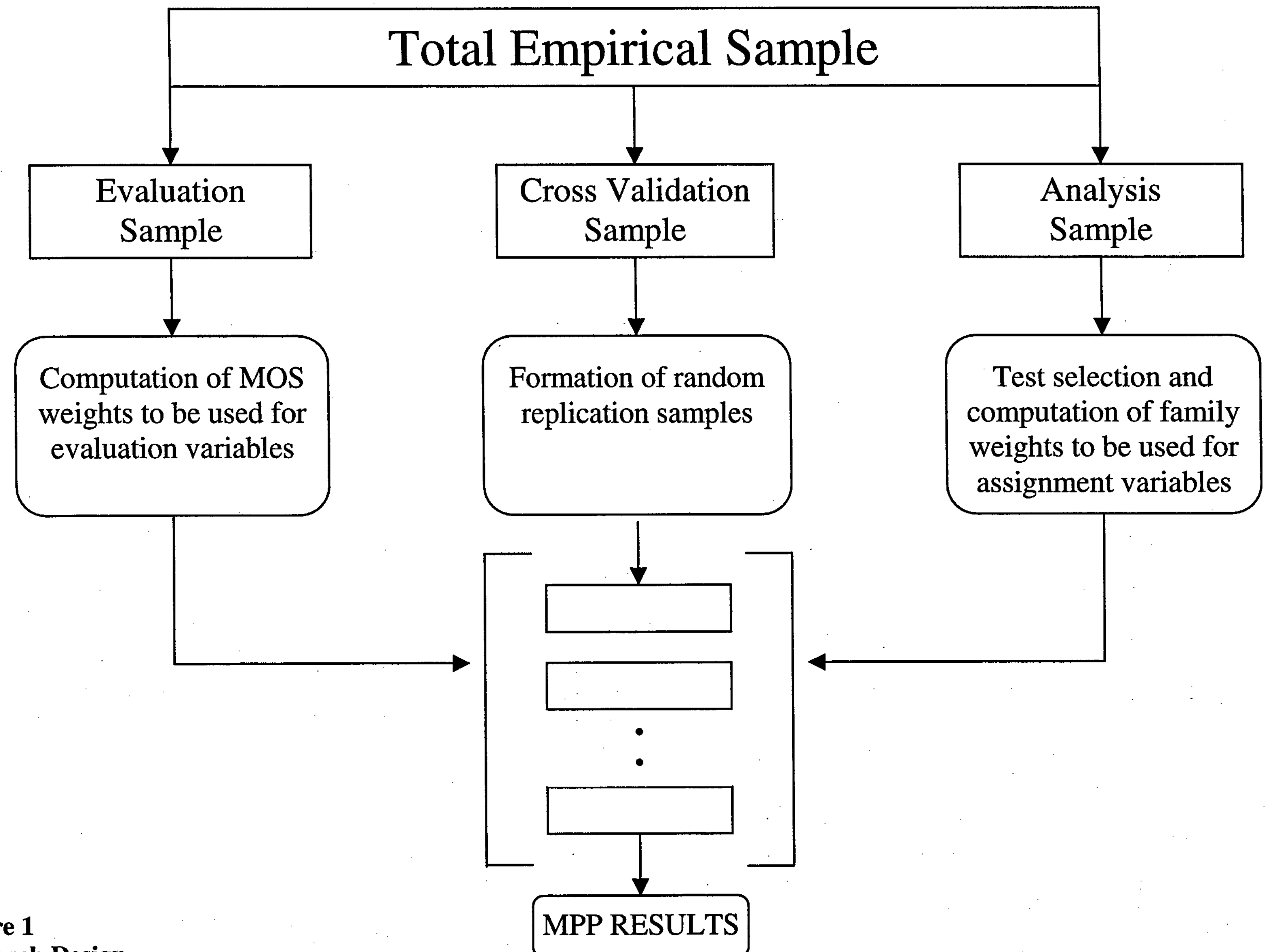

Figure 1
Research Design

RESULTS AND DISCUSSION

The 17-Job Family Second-Tier Structure

Table 1 shows the 17 job families (1989 MOS vintage) used in this study. The 17 job families were derived by shredding out the 9 job families structure, which is currently used in the interim operational battery. An examination of Table 1 shows that the 17 family structure provides for a more homogeneous and rational clusters of job families than does the 9-family structure shown in Table 4. The total sample size used in the triple-cross validation design (A+B+C) for the computation of all MPPs is 260,000.

Table 1
17-Family Structure

Cluster # 1		
71D	Legal Specialist	CL
71G	Patient Administration Specialist	CL
71L	Administrative Specialist	CL
71M	Chaplain Assistant	CL
73C	Finance Specialist	CL
73D	Accounting Specialist	CL
75B	Personnel Administration Specialist	CL
75C	Personnel Management Specialist	CL
75D	Personnel Records Specialist	CL
75E	Personnel Actions Specialist	CL
75F	Personnel Information Sys Mgt Specialist	CL
76P	Material Control and Accounting Specialist	CL
88N	Traffic Management Coordinator	CL
Cluster # 2		
76J	Medical Supply Specialist	CL
76V	Material Storage and Handling Specialist	CL
76X	Subsistence Supply Specialist	CL
77F	Petroleum Supply Specialist	CL
92A	Automated Logistical Specialist	CL
92Y	Unit Supply Specialist	CL
Cluster # 3		
11B	Infantryman	CO
11C	Indirect Fire Infantryman	CO
11H	Heavy Anti-Armor Weapons Infantryman	CO
11M	Fighting Vehicle Infantryman	CO

Cluster # 4

12B	Combat Engineer	CO
12C	Bridge Crewmember	CO
12F	Engineering Tracked Vehicle Crewman	CO
19D	Cavalry Scout	CO
19E	M48-M60 Armor Crewman	CO
19K	M1 Abrams Armor Crewman	CO

Cluster # 5

24Z	Hawk Firing Section Mechanic	EL
31L	Wire Systems Installer	EL
31R	Multichannel Transmission Systems Operator	EL
31V	Unit Level Communications Maintainer	EL
51R	Interior Electrician	EL
68M	Aircraft Weapon Systems Repairer	EL

Cluster # 6

31K	Combat Signaler	EL
31N	Communications Systems/Circuit Controller	EL
31P	Microwave Systems Operator-Maintainer	EL
31Q	Tactical Satellite/Microwave System Op	EL
31S	Satellite Communications System Operator	EL
36M	Switching Systems Operator	EL
55G	Nuclear Weapons Specialist	EL
93F	Field Artillery Meteorological Crewmember	EL
96R	Ground Surveillance Systems Operator	EL

Cluster # 7

27E	TOW/Dragon Repairer	EL
27Z	Hawk Firing Section Repairer	EL
29V	Strategic Microwave Systems Repairer	EL
29Z	Fixed Communications Security Equip Repairer	EL
35E	Radio and Communications Security Repairer	EL
35H	TMDE Maintenance Support Specialist	EL
35J	Telecommunications Terminal Device Repairs	EL
35N	Wire Systems Equipment Repairer	EL
68J	Aircraft Armament/Missile Systems Repairer	EL
68N	Avionic Mechanic	EL
68Z	Avionic Communications Equipment Repairer	EL

Cluster # 8

13B	Cannon Crewmember	FA
13C	Tacfire Operations Specialist	FA
13E	Cannon Fire Direction Specialist	FA
13F	Fire Support Specialist	FA

Cluster # 9

41C	Fire Control Instrument Repairer	GM
44B	Metal Worker	GM
44E	Machinist	GM
45B	Small Arms Repairer	GM
45D	Self-Propelled FA Turret Mechanic	GM
45K	Tank Turret Repairer	GM
45L	Artillery Repairer	GM
45T	Bradley Fighting Vehicle Sys Turret Mech	GM
52C	Utility Equipment Repairer	GM
52D	Power Generator Equipment Repairer	GM

Cluster # 10

51B	Carpentry and Masonry Specialist	GM
51K	Plumber	GM
51M	Firefighter	GM
55B	Ammunitions Specialist	GM
55D	Explosive Ordinance Disposal (EOD) Spec	GM
57E	Laundry and Bath Specialist	GM
62E	Heavy Construction Equipment Operator	GM
62F	Crane Operator	GM
62J	General Construction Equipment Operator	GM
77W	Water Treatment Specialist	GM
88H	Cargo Specialist	GM
92M	Mortuary Affairs Specialist	GM
92R	Parachute Rigger	GM

Cluster # 11

45E	M1 Abrams Tank Turret Mechanic	MM
45N	M60A1/A3 Tank Turret Mechanic	MM
62B	Construction Equipment Repairer	MM
63B	Light-Wheel Vehicle Mechanic	MM
63D	Self-Propelled Field Artillery Sys Mech	MM
63E	M1 Abrams Tank System Mechanic	MM
63G	Fuel and Electrical System Repairer	MM
63H	Track Vehicle Repairer	MM
63J	Quartermaster and Chemical Equip Repairer	MM
63N	M60A1/A3 Tank System Mechanic	MM
63S	Heavy-Wheel Vehicle Mechanic	MM
63T	Bradley Fighting Vehicle Sys Mechanic	MM
63W	Wheel Vehicle Repairer	MM
63Y	Track Vehicle Mechanic	MM

Cluster # 12

67N	Utility Helicopter Rpairer	MM
67R	AH-64 Attack Helicopter Repairer	MM
67T	Tactical Transport Helicopter Rpairer	MM
67U	Medium Helicopter Repairer	MM
67V	Observation/Scout Helicopter Repairer	MM
67Y	AH-1 Attack Helicopter Repairer	MM
68B	Aircraft Powerplant Repairer	MM
68D	Aircraft Powertrain Repairer	MM
68F	Aircraft Electrician	MM
68G	Aircraft Structural Repairer	MM

Cluster # 13

13M	Multiple Launch Rocket Sys (MLRS) Crewmember	OF
13N	Lance Crewmember	OF
14D	Hawk Missile Crewmember	OF
15E	Pershing Missile Crewmember	OF
16E	Hawk Fire Control Crewmember	OF
16J	Defense Acquisition Radar Operator	OF
16P	Chaparral Crewmember	OF
16R	Vulcan Crewmember	OF
16S	Man Portable Air Defense System Crewmember	OF
88M	Motor Transport Operator	OF
91M	Hospital Food Service Specialist	OF
92G	Food Service Specialist	OF

Cluster # 14

13R	Fa Firefinder Radar Operator	SC
31C	Single Channel Radio Operator	SC
72E	Tactical Telecommunications Center Op	SC
72G	Automatic Data Telecommunications Center Op	SC

Cluster # 15

91A	Medical Specialist	ST
91D	Operating Room Specialist	ST
91E	Dental Specialist	ST
91F	Psychiatric Specialist	ST
91G	Behavioral Science Specialist	ST
91K	Medical Laboratory Specialist	ST
91P	X-Ray Specialist	ST
91Q	Pharmacy Specialist	ST
91R	Veterinary Food Inspection Specialist	ST
91S	Preventive Medicine Specialist	ST
91T	Animal Care Specialist	ST
91Z	Orthopedic Specialist	ST

Cluster # 16

25M	Graphics Documentation Specialist	ST
25S	Still Documentation Specialist	ST
25Z	Cartographer	ST
46Z	Journalist	ST
51T	Technical Engineering Specialist	ST
74B	Information Systems Operator	ST
81L	Printing and Bindery Specialist	ST
96B	Intelligence Analyst	ST
96D	Imagery Analyst	ST
97B	Counterintelligence Agent	ST
97E	Interrogator	ST
98C	Signals Intelligence Analyst	ST
98G	EW Signal Intelligence Voice Interrogator	ST
98H	Morse Interceptor	ST
98Z	Emitter Locator/Identifier	ST

Cluster # 17

54B	Chemical Operations Specialist	ST
82C	Field Artillery Surveyor	ST
93C	Air Traffic Control (ATC) Operator	ST
93P	Flight Operations Coordinator	ST
95B	Military Police	ST
95C	Corrections Specialist	ST

MPPs for the 17-Family Structures for Army/Youth Populations

Table 2 shows MPPs and standard deviations for the 17-family structure for both biased (back) and unbiased (cross) values. The overall MPP consists of a weighted average which takes into account sample sizes of MOS. See Zeidner, et al. (August. 2000) for a description of simulation procedures.

The overall MPP is .088 in the cross samples for the ACSS scale. While this is substantially greater than the previous operational unit-weighted AA system, there was a considerable reduction in MPP of about .05 compared to the best weighted statistical standard scale. This is due to the loss of validity-based hierarchical effects (capitalizing on variations in standard deviations proportional to validities) that results from the use of the ACSS scale (Zeidner, et al., Aug. 2000). In the system envisioned by the authors, the first tier is to be used in

making initial job assignments based on predicted performance of each of the 150-job families and the use of the second tier system would need a lesser degree of classification efficiency for purposes of counseling and for setting cut scores. In practice, very low cut scores are used and the vast majority of recruits qualify for most jobs. However, if the interim operational ACSS scale is used for assignment, there would be, as noted, a significant reduction in classification efficiency.

As noted earlier, only positive weights are used in the computation of MPPs; fortunately, employing positive weights reduces MPPs by only a trivial amount. Note that of the 17 unbiased MPPs given in Table 2, 9 are negative. The largest negative is an MPP of -.338 for job family 8, Field Artillery; all other negative MPPs are -.233 or less. It should be noted that the negative MPP values are for a statistical standard score scale that has a mean of zero in the Army input population, and this zero point corresponds to a mean score estimated to range from 108 to 103 on the ACSS scale, depending on the composite considered. The means of these scores have a standard deviation in each sample that ranges from .01 to .03.

A constraint on the operational assignment system could be imposed to prevent MPPs for any job family dropping below a minimum MPP value of zero. However, in previous research (Zeidner, Johnson, Vladimirsky & Weldon, August, 2000) it was found that such a constraint resulted in a considerable reduction in overall MPP.

Table 2
MPPs and SDs for 17-Job Families for the Army Population (7 ASVAB Tests)

Average Back

	MPP	STD
	0.1209747	0.0113342
1	0.0919395	0.0427099
2	-0.0610568	0.0354186
3	0.2731783	0.0287658
4	0.1545699	0.0432278
5	0.0120387	0.0647008
6	0.3227060	0.1054840
7	-0.3001503	0.0888250
8	0.0813665	0.0451180
9	0.2159626	0.1056830
10	0.3441606	0.0837164
11	0.3614845	0.0315184
12	-0.0629089	0.0986637
13	0.1681162	0.0432271
14	-0.0840853	0.0782185
15	-0.0222166	0.0407737
16	-0.0512207	0.0758849
17	-0.1895286	0.0644460

Average Cross

	MPP	STD
	0.0884304	0.0114036
1	0.0925419	0.0424537
2	-0.0639651	0.0353555
3	0.2570768	0.0293506
4	0.1197183	0.0438512
5	-0.0507781	0.0632346
6	0.3243856	0.1056220
7	-0.3388867	0.0893281
8	-0.0272347	0.0476275
9	0.1979221	0.1075892
10	0.3134463	0.0865347
11	0.3605558	0.0317055
12	-0.1728844	0.1006270
13	0.1296355	0.0433960
14	-0.1269465	0.0797306
15	-0.0452573	0.0404403
16	-0.1256800	0.0789761
17	-0.2300531	0.0638792

Table 3 shows the MPPs for the 17-families for the youth population. The overall MPP is .280, but it is important to stress that the MPP in this computation reflects both selection and classification effects.

The overall mean of the sample C composite scores, prior to assignment, provides a measure of the overall MPP due to selection effects. We found this MPP to be equal to .200. This value represents the effect on MPP of selecting the Army input from the youth population. Such selection effects may be attributable to such factors as AFQT standards, educational levels, medical requirements and several other standards or requirements. Thus, in the youth population, of the MPP of .280, about .080 or only 30 percent of the total MPP is due to classification. In contrast, we found in an earlier study that 55 percent was due to classification and 45 percent was due to selection when only the selection effect of AFQT was considered in screening the youth population to obtain the Army input sample (Zeidner, Johnson, Vladimirsky & Weldon, August, 2000).

Note that in Table 3, only one of 17 families has a negative MPP of -.046 in the youth population compared to seven negative families in the Army population, although both samples have similar overall MPPs.

Again, we note much reduced MPPs for the 17-job families attributable to classification in the youth population. This reflects removal of hierarchical effects due to the use of the ACSS scale that stipulates equal variances among composites.

Table 3
MPPs and SDs for 17Job Families for the Youth Population (7 ASVAB Tests)

Average Back

	MPP	STD
	0.3088484	0.0098548
1	0.2521735	0.0372478
2	0.1286509	0.0312550
3	0.4106585	0.0268289
4	0.3339102	0.0384839
5	0.2239396	0.0559501
6	0.4869739	0.0912797
7	-0.0119029	0.0772481
8	0.2620536	0.0395057
9	0.4098846	0.0868044
10	0.4974469	0.0746717
11	0.5633350	0.0268940
12	0.1955718	0.0828613
13	0.3533439	0.0377683
14	0.1247274	0.0683708
15	0.1764263	0.0361184
16	0.1778729	0.0609258
17	0.0709800	0.0544623

Average Cross

	MPP	STD
	0.2795958	0.0100035
1	0.2526657	0.0370882
2	0.1259442	0.0312221
3	0.3946356	0.0275905
4	0.3027961	0.0391098
5	0.1695617	0.0551636
6	0.4838843	0.0915669
7	-0.0464066	0.0777039
8	0.1567794	0.0418666
9	0.3960908	0.0881386
10	0.4744890	0.0768359
11	0.5624284	0.0270677
12	0.1024299	0.0843872
13	0.3192584	0.0378962
14	0.0841184	0.0700622
15	0.1556007	0.0358630
16	0.1173430	0.0631949
17	0.0378976	0.0537804

The 9-Job Family Structure

Table 4 shows the 9-job family structure (1989 vintage MOS). This is actually the same structure being employed in the Army interim operational battery. Because there are only 9 job families, or clusters, they are comprised of more diverse families compared to the more homogeneous 17-family structure shown in Table 1.

Table 4
9-Families Interim Operational Structure

Cluster # 1

71D	Legal Specialist	CL
71G	Patient Administration Specialist	CL
71L	Administrative Specialist	CL
71M	Chaplain Assistant	CL
73C	Finance Specialist	CL
73D	Accounting Specialist	CL
75B	Personnel Administration Specialist	CL
75C	Personnel Management Specialist	CL
75D	Personnel Records Specialist	CL
75E	Personnel Actions Specialist	CL
75F	Personnel Information Sys Mgt Specialist	CL
76J	Medical Supply Specialist	CL
76P	Material Control and Accounting Specialist	CL
76V	Material Storage and Handling Specialist	CL
76X	Subsistence Supply Specialist	CL
77F	Petroleum Supply Specialist	CL
88N	Traffic Management Coordinator	CL
92A	Automated Logistical Specialist	CL
92Y	Unit Supply Specialist	CL

Cluster # 2

11B	Infantryman	CO
11C	Indirect Fire Infantryman	CO
11H	Heavy Anti-Armor Weapons Infantryman	CO
11M	Fighting Vehicle Infantryman	CO
12B	Combat Engineer	CO
12C	Bridge Crewmember	CO
12F	Engineering Tracked Vehicle Crewman	CO
19D	Cavalry Scout	CO
19E	M48-M60 Armor Crewman	CO
19K	M1 Abrams Armor Crewman	CO

Cluster # 3

24Z	Hawk Firing Section Mechanic	EL
27E	TOW/Dragon Repairer	EL
27Z	Hawk Firing Section Repairer	EL
29V	Strategic Microwave Systems Repairer	EL
29Z	Fixed Communications Security Equip Repairer	EL
31K	Combat Signaler	EL
31L	Wire Systems Installer	EL
31N	Communications Systems/Circuit Controller	EL
31P	Microwave Systems Operator-Maintainer	EL
31Q	Tactical Satellite/Microwave System Op	EL
31R	Multichannel Transmission Systems Operator	EL
31S	Satellite Communications System Operator	EL
31V	Unit Level Communications Maintainer	EL
35E	Radio and Communications Security Repairer	EL
35H	TMDE Maintenance Support Specialist	EL
35J	Telecommunications Terminal Device Repairs	EL
35N	Wire Systems Equipment Repairer	EL
36M	Switching Systems Operator	EL
51R	Interior Electrician	EL
55G	Nuclear Weapons Specialist	EL
68J	Aircraft Armament/Missile Systems Repairer	EL
68M	Aircraft Weapon Systems Repairer	EL
68N	Avionic Mechanic	EL
68Z	Avionic Communications Equipment Repairer	EL
93F	Field Artillery Meteorological Crewmember	EL
96R	Ground Surveillance Systems Operator	EL

Cluster # 4

13B	Cannon Crewmember	FA
13C	Tacfire Operations Specialist	FA
13E	Cannon Fire Direction Specialist	FA
13F	Fire Support Specialist	FA

Cluster # 5

41C	Fire Control Instrument Repairer	GM
44B	Metal Worker	GM
44E	Machinist	GM
45B	Small Arms Repairer	GM
45D	Self-Propelled FA Turret Mechanic	GM
45K	Tank Turret Repairer	GM
45L	Artillery Repairer	GM
45T	Bradley Fighting Vehicle Sys Turret Mech	GM
51B	Carpentry and Masonry Specialist	GM
51K	Plumber	GM
51M	Firefighter	GM
52C	Utility Equipment Repairer	GM
52D	Power Generator Equipment Repairer	GM
55B	Ammunitions Specialist	GM
55D	Explosive Ordinance Disposal (EOD) Spec	GM
57E	Laundry and Bath Specialist	GM
62E	Heavy Construction Equipment Operator	GM
62F	Crane Operator	GM
62J	General Construction Equipment Operator	GM
77W	Water Treatment Specialist	GM
88H	Cargo Specialist	GM
92M	Mortuary Affairs Specialist	GM
92R	Parachute Rigger	GM

Cluster # 6

45E	M1 Abrams Tank Turret Mechanic	MM
45N	M60A1/A3 Tank Turret Mechanic	MM
62B	Construction Equipment Repairer	MM
63B	Light-Wheel Vehicle Mechanic	MM
63D	Self-Propelled Field Artillery Sys Mech	MM
63E	M1 Abrams Tank System Mechanic	MM
63G	Fuel and Electrical System Repairer	MM
63H	Track Vehicle Repairer	MM
63J	Quartermaster and Chemical Equip Repairer	MM
63N	M60A1/A3 Tank System Mechanic	MM
63S	Heavy-Wheel Vehicle Mechanic	MM
63T	Bradley Fighting Vehicle Sys Mechanic	MM
63W	Wheel Vehicle Repairer	MM
63Y	Track Vehicle Mechanic	MM
67N	Utility Helicopter Rpairer	MM
67R	AH-64 Attack Helicopter Repairer	MM
67T	Tactical Transport Helicopter Rpairer	MM
67U	Medium Helicopter Repairer	MM
67V	Observation/Scout Helicopter Repairer	MM
67Y	AH-1 Attack Helicopter Repairer	MM
68B	Aircraft Powerplant Repairer	MM
68D	Aircraft Powertrain Repairer	MM
68F	Aircraft Electrician	MM
68G	Aircraft Structural Repairer	MM

Cluster # 7

13M	Multiple Launch Rocket Sys (MLRS) Crewmember	OF
13N	Lance Crewmember	OF
14D	Hawk Missile Crewmember	OF
15E	Pershing Missile Crewmember	OF
16E	Hawk Fire Control Crewmember	OF
16J	Defense Acquisition Radar Operator	OF
16P	Chaparral Crewmember	OF
16R	Vulcan Crewmember	OF
16S	Man Portable Air Defense System Crewmember	OF
88M	Motor Transport Operator	OF
91M	Hospital Food Service Specialist	OF
92G	Food Service Specialist	OF

Cluster # 8

13R	Fa Firefinder Radar Operator	SC
31C	Single Channel Radio Operator	SC
72E	Tactical Telecommunications Center Op	SC
72G	Automatic Data Telecommunications Center Op	SC

Cluster # 9

25M	Graphics Documentation Specialist	ST
25S	Still Documentation Specialist	ST
25Z	Cartographer	ST
46Z	Journalist	ST
51T	Technical Engineering Specialist	ST
54B	Chemical Operations Specialist	ST
74B	Information Systems Operator	ST
81L	Printing and Bindery Specialist	ST
82C	Field Artillery Surveyor	ST
91A	Medical Specialist	ST
91D	Operating Room Specialist	ST
91E	Dental Specialist	ST
91F	Psychiatric Specialist	ST
91G	Behavioral Science Specialist	ST
91K	Medical Laboratory Specialist	ST
91P	X-Ray Specialist	ST
91Q	Pharmacy Specialist	ST
91R	Veterinary Food Inspection Specialist	ST
91S	Preventive Medicine Specialist	ST
91T	Animal Care Specialist	ST
91Z	Orthopedic Specialist	ST
93C	Air Traffic Control (ATC) Operator	ST
93P	Flight Operations Coordinator	ST
95B	Military Police	ST
95C	Corrections Specialist	ST
96B	Intelligence Analyst	ST
96D	Imagery Analyst	ST
97B	Counterintelligence Agent	ST
97E	Interrogator	ST
98C	Signals Intelligence Analyst	ST
98G	EW Signal Intelligence Voice Interrogator	ST
98H	Morse Interceptor	ST
98Z	Emitter Locator/Identifier	ST

MPPs for the 9-Family Structure for Army Input / Youth Populations

Table 5 shows an overall MPP in the cross samples of .081 for the nine composites in the Army population. Five of the nine have negative MPPs, with the largest being -.143. Again, as noted earlier, on the ACSS scale, composite means range from about 108 – 103 and constraints could be imposed to remove negative means, but at a cost in MPP.

Table 5
MPPs and SDs for 9 Job Families for the Army Population (7 ASVAB Tests)

Average Back

	MPP	STD
	0.1045756	0.0118033
1	-0.0467859	0.0275303
2	0.2216089	0.0234895
3	-0.0267011	0.0568885
4	0.0904811	0.0452090
5	0.3486981	0.0714379
6	0.3080385	0.0306513
7	0.1294610	0.0352490
8	-0.0398629	0.0802767
9	-0.1215549	0.0289731

Average Cross

	MPP	STD
	0.0806103	0.0117229
1	-0.0478593	0.0277025
2	0.2050592	0.0238509
3	-0.0459751	0.0568577
4	-0.0179484	0.0461027
5	0.3344511	0.0711348
6	0.3044704	0.0309717
7	0.0881079	0.0352463
8	-0.0824404	0.0813521
9	-0.1438539	0.0290662

Table 6 shows an overall MPP of .272 for the nine composites in the youth population. Again, as noted earlier, only about .07 is attributable to classification (.272 – .200). All MPPs are positive for these 9 composites in this population.

Table 6
MPPs and SDs for 9-Job Families for the Youth Population (7 ASVAB Tests)

Average Back

	MPP	STD
	0.2939450	0.0100843
1	0.1325426	0.0275331
2	0.3989293	0.0216500
3	0.1715817	0.0452321
4	0.2440419	0.0422628
5	0.4835140	0.0575693
6	0.5155470	0.0262005
7	0.3223041	0.0368781
8	0.1498037	0.0640041
9	0.1071606	0.0251009

Average Cross

	MPP	STD
	0.2716569	0.0100979
1	0.1317763	0.0275838
2	0.3832748	0.0216144
3	0.1536393	0.0452540
4	0.1339917	0.0442302
5	0.4704717	0.0581209
6	0.5125288	0.0264717
7	0.2855920	0.0378210
8	0.1084181	0.0652395
9	0.0889139	0.0255631

Comparison of MPPs for the Two Job Families for Army/Youth Populations

Table 7 shows a comparison of the two sets of families (17- and 9-job families and 7 ASVAB tests) for the Army and youth populations. We find only a negligible difference of less than .01 between the MPPs for both Army and youth populations.

Table 7
Comparison of MPPs for the Two Job Families for the Army/Youth Population in Cross Samples

	Army		Youth	
Number of Families	MPP	SD	MPP	SD
17	.088	.011	.280	.010
9	.081	.011	.272	.010

Comparison of Sets of Families with Varying Tests

In an earlier study employing LSEs and statistical standard scores, the composites for the 17-job family, based on 9 ASVAB tests (17/9) showed an overall mean MPP difference of about .02 greater than the composites for the 9-job families, also based on 9 ASVAB tests (9/9) for the Army population (Zeidner, Johnson, Vladimirsky & Weldon, August, 2000). In the present study, we computed these sets of MPPs to show each individual family MPP (in addition to the overall MPPs) but with a conversion to the ACSS scale. Table 8 shows the MPPs for 17/9 and Table 9 shows the MPPs for the 9/9. Here we find the overall difference is less than .01.

Table 8
MPPs and SDs for 17-Job Families for the Army Population (9 ASVAB Tests)

Average Back

	MPP	STD
	0.1423162	0.0113012
1	0.0443760	0.0538292
2	-0.0480783	0.0436422
3	0.2140592	0.0221501
4	0.2039505	0.0432543
5	0.0476824	0.0790682
6	0.3142959	0.1024236
7	-0.3887277	0.0793288
8	0.1789533	0.0422577
9	0.4336617	0.1098654
10	0.2639857	0.0951938
11	0.4180940	0.0240785
12	-0.1482182	0.1019502
13	0.2033526	0.0396269
14	-0.0025294	0.0945033
15	0.0889467	0.0553339
16	0.0494043	0.0827986
17	-0.2203339	0.0525149

Average Cross

	MPP	STD
	0.0982138	0.0114831
1	0.0422782	0.0549833
2	-0.0586347	0.0446793
3	0.1726743	0.0233421
4	0.1644337	0.0438769
5	-0.0234623	0.0784953
6	0.2390137	0.1027923
7	-0.4398490	0.0797215
8	0.0824393	0.0445575
9	0.4205659	0.1121323
10	0.2227343	0.0978142
11	0.4161709	0.0243973
12	-0.2661961	0.1052592
13	0.1637883	0.0393866
14	-0.0465264	0.0953722
15	0.0622534	0.0539206
16	-0.0444302	0.0827010
17	-0.3000335	0.0532174

Table 9
MPPs and SDs for 9-Job Families for the Army Population (9 ASVAB Tests)

Average Back

	MPP	STD
	0.1177304	0.0115082
1	-0.0842797	0.0277791
2	0.2007949	0.0228460
3	-0.0921594	0.0603800
4	0.1719158	0.0483645
5	0.3905508	0.0864353
6	0.3538039	0.0287131
7	0.1779566	0.0375501
8	-0.0155003	0.0758521
9	-0.0628107	0.0348641

Average Cross

	MPP	STD
	0.0891673	0.0116274
1	-0.0866723	0.0280372
2	0.1698061	0.0237057
3	-0.1158949	0.0603509
4	0.0732582	0.0514635
5	0.3674181	0.0873652
6	0.3483130	0.0287395
7	0.1369022	0.0376290
8	-0.0664786	0.0762552
9	-0.0849143	0.0340226

Proportionately, examining the 17/7 (Table 7) with the 9/7 (Table 5) for the ACSS scale, we get comparable reductions. For convenience, these results are also shown in Table 10. Since the interim operational battery uses the ACSS scale, with equal means and equal standard deviations, the MPP advantage of 17/7 over 9/7 is almost trivial (.009).

Table 10
Comparison of Army MPPs for Two Job Families Using 9 or 7 ASVAB Tests in Cross Samples

	Number of Tests	
Number of Families	9 ASVAB Tests	7 ASVAB Tests
17	.098	.088
9	.089	.081

Note:
(1) MPPs are for composites based on the Army Conventional Standard Score (ACSS) Scale.
(2) In the Army population, the weighted average validity of 17/7 composites is .479 and for the 9/7 composites is .478. In the youth population the composite validities are .542 and .541, respectively. (See Zeidner, Johnson, Vladimirsky & Weldon, Oct. 2002.)

As noted, the ACSS scale also is used to establish minimum cut scores for assignment purposes. Here, the validity coefficients of composites must also be considered to assess the relative advantage of the 17/7 family set over the 9/7 family set. In the footnote of Table 10, we give the validities for the two sets of families for the Army and youth populations. The values for the sets of families are nearly identical (.479 vs. .478 for the Army and .542 vs. .541 for the youth population). Thus, comparing both sets of MPPs and validities for the ACSS scale, the 9/7 set is about equivalent to the 17/7 family with respect to either selection or classification efficiency.

SUMMARY AND CONCLUSIONS

Summary

The primary focus of the present study was to obtain MPPs for the Army's interim composites based on the 7 test operational battery, composites that employ the Army conventional standard score (ACSS) scale with equal means and equal standard deviations for its

nine composites. Interim composites based on the existing 9 job families based on the 7-ASVAB test battery (9/7) are contrasted with composites for 17-job families, 7-ASVAB tests (17/7). Weights are corrected first for unreliability of the criteria and, then, for restriction in range effects due to assignment from an Army input population to MOS samples. Weights are applied to test scores of an independent sample to obtain back and cross MPPs. Youth population values involve an additional separate restriction-in-range correction due to selection from the youth population into the Army.

The study found that an MPP loss of only .009 was incurred due to the reduction from 17/7 to 9/7. However, a comparison of 17/9 with 9/7 shows a significant MPP loss of .017. Although the former 9 ASVAB test composites are not a viable current alternative, the use of the 9/7 interim battery rather than a 17/9 battery incurs a 21% reduction in MPP for composites using the ACSS scale (which does not capitalize on hierarchical effects).

Fortunately, the overall composite validity coefficient of .54 in the youth population (used in computing cut scores) is essentially the same for both the 9/7 interim composites and for the 17/7 composites on the ACSS scale.

Conclusions

The Army has decided to use an operational battery of 7 ASVAB tests and 9 interim best weighted composites. The "best weighted" LSE composites have been transformed into the Army's conventional scale, eliminating hierarchical effects from the composites. This use of the ACSS scale results in a major reduction in MPP. This and other potential, but lesser, reductions due to constraining optimal assignments to remove negative MPPs in each family and the use of only positive test weights further reduce MPP, but by only relatively trivial amounts.

Given that composites will continue to be converted to the ACSS scale, the use of 17/7 composites rather than the 9/7 scale each with equal composite validities would be of no practical significance.

The recommendation of the authors for a two-tiered system remains (Zeidner, Johnson, Vladimirsky & Weldon, Aug. 2000). The first tier, the invisible system, provides the 150-job-family assignment system and has an MPP of about .190 (with optimal assignment) for a 7 ASVAB test battery. The second tier, the visible system, could use the current 9 interim operational composites. Since it would be used primarily for record keeping, counseling and possibly for determining cut scores, the loss of MPP would not impact classification efficiency.

The change in the authors' recommendation concerning the second tier has been brought about by the results of this study which do not show a non-trivial advantage for the 17/7 composites and, also, by the reduction of the ASVAB from 9 to 7 tests. Given these conditions, the impact on MPP of 17- over 9-job families appears to lie in the appearance of greater homogeneity of the 17 composites.

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Appendix

Impact of Restriction in Range on the Estimation of AA Composites

Introduction

This appendix will focus on how to obtain the AA composite regression weights (referred to as "u and k" values) for operational use in the applicant Youth Population.[3] The validity coefficients we wish to maximize in the Youth Population actually exist only in doubly restricted MOS samples containing the Skill Qualifications Test (SQT) criterion in the 1987 - 1989 research data set. Appropriate corrections have to be made to these restricted validity coefficients to obtain unrestricted validity coefficients that, if subjected to restriction in range effects, would equal what was obtained in the MOS samples. We also have to estimate what the criterion standard deviation (SD) would have to be in the unrestricted population to yield the criterion SDs observed in the MOS samples.[4]

The Army operational process involves an applicant Youth Population from which self-selection first occurs, and then the Recruiting Command selects some and rejects others using tests, medical examinations, security investigations etc. This results in an Army Input Population from which classification and assignment procedures and further self selection create the 150 MOS samples, each with its separate SQT criterion measure. Thus there is a selection stage and a classification and assignment stage, with a restriction in range effect on both test scores and hypothetical criterion scores occurring at both stages. If we confined selection effects to the impact of the AFQT screen, the two kinds of effects would have to be corrected in a sequential manner. However, since we are not restricting ourselves to such a limited selection effect, and are instead considering all effects on the subtest co-variances at each restriction stage, we can correct validity coefficients and criterion SDs directly to the Youth Population.

Our correction process for restriction in range involves contrasting, separately for each MOS, the within-MOS subtest variance/co-variances against the Youth Population operational test variance/co-variances. The differences in the variance/co-variances across the unrestricted and the restricted samples for variables specified as explicitly selected variables are the measures of the magnitude of the restriction effect. For our purposes we use all ASVAB subtests as the explicitly restricted variables and we designate the criterion variables as the implicitly restricted variables that are restricted to the extent that they are predicted by the explicitly restricted variables.

Using this concept we can calculate the effect selection has on subtest scores and can then calculate the further effect classification and assignment has on test scores in the Army Input Population – to arrive at the doubly restricted subtest scores in the MOS samples. Considering the correlation of the subtest scores with the criterion scores and the amount of

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[3] This appendix has been prepared by Cecil Johnson, consulting research psychologist.

[4] It should be noted that whenever validity coefficients are mentioned, we are assuming that these coefficients have been corrected for attenuation with respect to criterion unreliability. Even if we should refer to an uncorrected validity coefficient (for restriction in range), this "uncorrected" coefficient has been corrected for attenuation.

restriction occurring at each stage, we can determine the restriction effect on the hypothetical criterion scores and then provide a correction extending from the MOS criterion scores to the less restricted populations where the criterion scores exist only as a function of the subtest scores (i.e., as predicted criterion scores).

Approach

There is more than one algebraically equivalent way of providing operational u and k values when criterion scores are only available on the doubly restricted MOS samples. We will use an approach that utilizes the equality of G-weights computed in the restricted and the unrestricted population (using Gulliksen's formulation as described below). The G-weights computed in the restricted population samples will be used as a substitute for the unobtainable G-weights in the unrestricted population in Gulliksen's formula for computing the criterion variance in the unrestricted population.

1. Consider the matrix of G-weights, G, in each MOS sample. Our use for G is as an entry value in Gulliksen's formula (see below). The corrected validity coefficients, obtained with the use of the formula at either or both the Army Input Population and Youth Population points, were then employed in computing Beta weights in the Youth Population. Note that this correction must be made from each MOS sample to the Youth population to produce validity coefficients corrected for restriction in range. These corrected MOS validity coefficients are then aggregated into a corrected validity for each specified family, using acquisition values to weight the MOS validity coefficients corrected to the Youth Population.
2. Visualize a composite computed for an individual by summing the product of each subtest standard score and B. The best weighted composite XB will have a SD equal to the validity of predicted performance (PP) in the Youth Population if the elements of the V matrix used in computing B are validity coefficients corrected for restriction in range to represent the Youth Population, and the R matrix consists of the inter-correlation coefficients among subtests as expected in the Youth Population. The criterion variables, predicted as least square estimates (LSEs) by the PP composites, have a SD equal to 1.0 in the restricted MOS samples, while the hypothetical unrestricted criterion variables would have larger SDs in the less restricted populations. Compute the Youth Population beta weights as follows:

   $$B = R^{-1} V^{T},$$

   where R is the Youth Population matrix of subtest inter-correlation coefficients and V is the matrix of validity coefficients corrected to the Youth Population. Looking at the formula in more detail,

   $$R = S_x C_{xx} S_x, \text{ and } V^T = S_x C_{xc} S_c,$$

   where C represents criterion / subtest variance and co-variances found in Gulliksen's formulae, and S represents a diagonal matrix where each diagonal element is equal to a reciprocal of a SD.
3. Compute b-weights by converting the Beta weights computed in step 2. The b-weights that are appropriate to apply to operational test scores to obtain a least squares estimate (LSE) of the criterion can be defined in terms of the Beta weights, the SDs of the subtests, and the SDs of the criterion scores. These b-weights applied to the operational test scores would provide

a composite that, if the appropriate regression constant were subtracted, would have a mean of 50 and a SD less than 10 (because of the effects of the positive inter-correlation coefficients among the subtests). The b-weights are computed, ignoring the regression constants, as follows:

$$\text{b-weight} = \text{B-weight} * (SD)_c \;/\; (SD)_t,$$

where t represents a subtest, $SD_t = 10$, and c represents the criterion variable.

4. The composite computed in step 3 will have a SD less than 10. We wish to convert this composite to have a SD of 20. To do this we will multiply each b-weight by a composite multiplier (CM) that will convert the composite to have a SD of 20 without affecting the composite mean. CM can be computed as follows.

$$CM = 20 / (10 * (\underline{b}R\underline{b}^T)^{1/2}),$$

where $\underline{b}$ is a vector of b-weights and R is the Youth Population matrix of subtest inter-correlation coefficients.

5. We can now compute the u and k values for each composite:

$$u_j = CM * \text{b-weight of the j-th subtest}$$

$$k = 100 - \sum u_j * 50$$

<u>Key Formulae From Gulliksen</u>

The algorithms we use to correct for restriction in range due to "selection" effects are developed and described by Gulliksen (1950)[5]. His development is based on a model that visualizes the presence of both explicit and implicit selection processes in the unrestricted population, and the presence of both explicitly and implicitly selected variables in the restricted population. Thus, both explicit and implicit variables are present in both the unrestricted and restricted populations. The author shows, in the context of this model, relationships among the restricted and unrestricted variances/co-variances without relaxing flexibility as to which population contains the unknowns that cannot be directly computed but can be determined on the basis of the relationships defined in his model.

The Gulliksen formulae for correcting variances and/or co-variances for restriction in range effects are based on Lawley's (1943) assumptions that include the following: (1) that the regression of the implicitly restricted variables on the explicitly restricted predictors is linear; (2) that the co-variance of the restricted variables exhibit homoscedasticity; and (3) that the G-weights for application to the population variance-covariance matrix of operational test scores (explicitly restricted variables, e.g., sub-tests) are invariant to the effects of restriction (as defined). Thus it is assumed that

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[5] See H. Gulliksen, *Theory of Mental Tests*. New York: John Wiley & Sons, 1950.

$$G = (C_{xx})^{-1} \; (C_{xc})^T$$

can be computed in a restricted population sample and substituted in formulae for use in the unrestricted population where a G-weight is to be entered. Gulliksen's formula 42, used to compute criterion variance in the Youth Population, requires such an entry. This criterion variance is essential for converting Beta-weights into b-weights and obviously cannot be directly computed in the Youth Population.

As previously stated, our objective is to have an algorithm replete with valid formulae that will convert operational test scores into LSEs of the criterion (i.e. PP composites) in a scale appropriate for use in the indicated population.

Application of Formulae 37 and 42

Applying combined formulae 37 and 42 to one criterion variable at a time, and making small changes in Gulliksen's notation, we can compute the squared SD of each Youth Population criterion variable associated with each job family. This result can be described as the Youth Population criterion variance, or YPCV:

$$YPCV = 1.0 + \underline{C}_{xc}\, (C_{xx})^{-1} \, (({}^*C_{xx})\, (C_{xx})^{-1} - I\,)(\underline{C}_{xc})^T,$$

where ($\underline{C}_{xc}$) is a 9 by 1 vector of co-variances between the criterion variable and each of the 9 tests, C_{xx} is a 9 by 9 matrix of co-variances among 9 tests using the operational test scores, and vectors are denoted by underlining. Note that the asterisk matrix, e.g. *C, indicates computation in the unrestricted (i.e. Youth Population) sample.[6]

The R matrix has the following relationship with the C_{xx} matrix:

$$R = S_x\, C_{xx}\, S_x,$$

[6] Note that YPCV can also be written as follows:

$$YPCV = 1.0 + (W^T)({}^*C_{xx}\, W - (\underline{C}_{xc})^T\,),$$

where $W = (C_{xx})^{-1} \; (\underline{C}_{xc})^T$, a 9 by 1 vector of regression weights for a specified job family. W will also be recognized as one column of the G matrix.

where S is a diagonal matrix for which the diagonal elements are equal to the reciprocals of the SDs of either the subtests or the criterion variable in either the MOS sample or the Youth Population, as indicated.

The $*C_{xc}^{T}$ matrix is derived from the Gulliksen formula as:

$$(*C_{xc})^{T} = (*C_{xx})\,(G) = (*C_{xx})\,(C_{xx})^{-1}(C_{xc})^{T}\,.$$

Note that one column of $*C_{xc}^{T}$ is $(\underline{C}_{xc})^{T}$, a vector used in the computation of YPCV. The validity matrix ($*V^{T}$) required to compute Beta weights in the Youth Population has the following relationship with the $*\underline{C}_{xc}^{T}$ vector:

$$\text{one column of } *V^{T} \text{ is } (*S_{x})\,(*\underline{C}_{xc})^{T}\,(*\underline{S}_{c})\,,$$

and note that $*\underline{S}_{c}$ is a scalar.

Positively Weighted Composites for the Visible Tier

This section extends the initially professed objectives of this appendix beyond restriction in range corrections and the conversion of Betas to u and k values. We will now discuss the methodology for selecting the "best" positively weighted composites where best is defined in terms of maximizing the multiple correlation coefficient of a set of tests with the criterion.

The surest way to find this best positively weighted composite from a set of n tests is to compute the Betas and validity coefficients for every possible combination of n tests, then successive levels: for n-1 tests, then n-2 tests, ...to 2 tests --- rejecting any combination of tests that has one or more negative weights. There is no need to actually consider all of these combinations since there comes a point in this process where all multiple correlation coefficients (Rs) for succeeding levels are lower than the highest R in a prior level.

The multiple-correlation coefficient, R, corresponding to each set of Betas is computed for each combination whether or not all of the weights are positive. Clearly, if the R for each combination of m-1 tests, negative weights permitted, was less than the highest R for m positively weighted subtests computed from the combinations considered at the prior level, the stopping point has been reached. After the stopping criterion has been reached, the set of subtests with all positively weighted coefficients that provides the maximum R is selected as the very best set and these weights become the B-weights for the associated subtests. All other tests are given a weight of zero in the composite associated with the specified job family.